FORM PTO-1390 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE ATTORNEY'S DOCKET NUMBER (REV 11-2000) 2490-17 (If known, see 37 C.F.R. 1.5) TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) 020619 **CONCERNING A FILING UNDER 35 U.S.C. 371** INTERNATIONAL APPLICATION NO. INTERNATIONAL FILING DATE PRIORITY DATE CLAIMED PCT/GB00/03483 08/09/2000 08/09/1999 TITLE OF INVENTION SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR APPLICANT(S) FOR DO/EO/US MASSARA, A. et al. Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information: This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 1.4 This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 2. П 3. \boxtimes This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. \boxtimes The U.S. has been elected by the expiration of 19 months from the priority date (Article 31). 5. A copy of the International Application as filed (35 U.S.C. 371(c)(2)). a. is attached hereto (required only if not communicated by the International Bureau). \boxtimes b. has been communicated by the International Bureau. \Box c. is not required, as the application was filed in the United States Receiving Office (RO/US). П An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. is attached hereto. h. has been previously submitted under 35 U.S.C. 154(d)(4). 7. 冈 Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. П are attached hereto (required only if not communicated by the International Bureau). \boxtimes b. have been communicated by the International Bureau. have not been made; however, the time limit for making such amendments has NOT expired. C. d. have not been made and will not be made. 8. An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). A English language translation of the annexes of the International Preliminary Examination Report under PCT 10₽ Article 36 (35 U.S.C. 371(c)(5)). Items 11 To 20 below concern document(s) or information included: 11. An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98. 12. An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. 13. \boxtimes A FIRST preliminary amendment. 14. A SECOND or SUBSEQUENT preliminary amendment. 15 A substitute specification. 16. A change of power of attorney and/or address letter. 17. A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825. A second copy of the published international application under 35 U.S.C. 154(d)(4). 18. 19. A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). \bowtie 20. Other items or information. PTO Form 1449

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In re Patent Application of

MASSARA, A. et al.

Atty. Ref.: 2490-17

Serial No. unknown

Group:

Filed: March 8, 2002

Examiner:

For: SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR

* * * * * * * * * *

March 8, 2002

Assistant Commissioner for Patents Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

In order to place the above-identified application in better condition for examination, please amend the application as follows:

IN THE SPECIFICATION

Please substitute the following paragraphs in the specification for corresponding paragraphs previously presented. A copy of the amended specification paragraphs showing current revisions is attached.

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/GB00/03483 filed 08 September 2000, which designated the US.

MASSARA, A. et al. Serial No. <u>unknown</u> IN THE CLAIMS

Please substitute the following amended claims for corresponding claims previously presented. A copy of the amended claims showing current revisions is attached.

- 3. An optical device as claimed in claim 1, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
- 4. An optical device as claimed in claim 1, wherein the individual elements are holes.
- 7. An optical device, as claimed in claim 4, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
- 8. An optical device, as claimed in claim 4, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.
- 9. An optical device, as claimed in claim 4, wherein the holes are regions of different refractive index to that of the device structure.
- 10. An optical device, as claimed in claim 4, wherein the holes are regions of different gain or loss to that of the device structure.

MASSARA, A. et al.

Serial No. unknown

- 11. An optical device, as claimed in claim 3, wherein the distributed reflector does not pierce the active region.
- 12. An optical device, as claimed in claim 3, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in claim 3, wherein the distributed reflector fully pierces the active region.
- 14. An optical device, as claimed in claim 1, wherein the distributed reflector is within the device.
- 17. An optical device as claimed in claim 1, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.
- 19. An optical device, as claimed in claim 1, which is integrated with separate amplifying, absorbing or passive sections.
 - 21. An optical device, as claimed in claim 1, with means for being pulsed

MASSARA, A. et al. Serial No. unknown

REMARKS

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page(s) is captioned "Version With Markings To Show Changes Made."

Respectfully submitted,

NIXON & VANDERHYE P.C.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Page 1, before the first line, please insert as a separate paragraph:

This application is the US national phase of international application PCT/GB00/03483 filed 08 September 2000, which designated the US.

IN THE CLAIMS

- 3. An optical device as claimed in claim 1-or-2, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
- 4. An optical device as claimed in claim 1, 2 or 3, wherein the individual elements are holes.
- 7. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
- 8. An optical device, as claimed in one of claims 4-to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.

MASSARA, A. et al.

Serial No. unknown

- 9. An optical device, as claimed in one of claims 4 to 8, wherein the holes are regions of different refractive index to that of the device structure.
- 10. An optical device, as claimed in one of claims 4 to 9, wherein the holes are regions of different gain or loss to that of the device structure.
- 11. An optical device, as claimed in one of claims 3-to 10, wherein the distributed reflector does not pierce the active region.
- 12. An optical device, as claimed in one of claims 3-to 10, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in one of claims 3-to-10, wherein the distributed reflector fully pierces the active region.
- 14. An optical device, as claimed in any preceding-claim 1, wherein the distributed reflector is within the device.
- 17. An optical device as claimed in any preceding claim 1, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.

MASSARA, A. et al. Serial No. unknown

- 19. An optical device, as claimed in any preceding claim 1, which is integrated with separate amplifying, absorbing or passive sections.
- 21. An optical device, as claimed in a in any preceding claim 1, with means for being pulsed by gain switching, Q-switching or mode-locking techniques.

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SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR

Laser devices are commonly used as light sources, and it is of particular interest to be able to obtain laser sources which have high quality spectral performance for data communication applications. It is of particular interest to be able to manufacture such devices in a relatively simple and low cost way, to achieve a robust device. In particular it is advantageous to achieve a device with a highly selective optical spectrum, that is, a device which produces a large amplitude peak at one specific wavelength of output light.

One type of laser device which can be used as such a source is a Distributed Feedback (DFB) laser, and the related Distributed Bragg Reflector (DBR) laser. However, conventional techniques for manufacturing such devices include regrowth steps, which make the manufacturing relatively expensive.

The paper "1.5 μ m wavelength DBR lasers consisting of $3\lambda/4$ -semiconductor and $3\lambda/4$ -groove buried with benzocyclobutene", M.M.Raj, J. Wiedmann, Y. Saka, H. Yasumoto and S. Arai. *Electronics Letter*, Vol.. 35, No. 16, pp. 1335-1337 describes a method of manufacturing deep etched (DBR) lasers. Since this technique involves etching into and across the active layer, the wave ceases to be guided within the etch, which means that these devices are likely to be inherently lossy.

The present invention relates to a laser device, with a ridge waveguide, with a distributed reflector on either side of the central ridge.

Since the light wave remains guided, this has the advantage that the device is relatively efficient.

Preferably, the reflector can be obtained by etching into the active layer on either side of the waveguide.

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This has the advantage that the reflector can be obtained without using additional regrowth steps.

Preferably, the reflector takes the form of a two-dimensional pattern. This allows efficient reflection, while allowing the reflector to be contained in a relatively short length of the device.

For a better understanding of the present invention, and to show how it may be put into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a plan view of a laser device in accordance with the invention.

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Figure 2 is an enlarged schematic illustration of a region of Figure 1.

Figure 3 is a cross-sectional view through the device of Figure 1.

Figure 4 illustrates the room temperature (20°C) CW optical spectra at 60mA for (a) pre-etch non-AR coated and (b) post-etch AR coated conditions of the device of Figure 1.

Figure 5 illustrates the post-etch room temperature (20°C) CW L-I characteristics of the device of Figure 1.

Figure 6 illustrates the post-etch, room temperature (20°C) variation of lasing wavelength with CW bias current for the device of Figure 1.

Figure 1 is a top plan view of a laser device in accordance with the invention. The device 2 is an InGaAsP-InP laser, with a ridge-waveguide 4. The device consists of seven 0.8% compressively strained quantum wells, and operates at a centre wavelength of ~1.29 μ m. The laser is 350 μ m long, and acts as a Fabry-Perot (F-P) laser. It is cleaved on both end facets 6,8. The laser is bonded junction side up on a temperature-controlled submount (not shown) and the output can be connected via a lensed fibre. The back

-3-

facet 6 is AR coated to 0.1%, in order to suppress the F-P modes.

Figure 3 is a cross-sectional view, taken on line A-A in Figure 1. As shown in Figure 3, the device has an active region 10 within the structure, with a silicon dioxide layer 12, having a metal layer 14 above it as the uppermost layers. The central ridge-waveguide has a width W of, for example, approximately $3\mu m$, with etched channels of width X of approximately $8\mu m$ on either side of the ridge waveguide.

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In accordance with the preferred embodiment of the invention, a distributed reflector structure is provided on either side of the central ridge waveguide, leaving the waveguide itself untouched.

In this illustrated embodiment of the invention, the distributed reflectors take the form of an etched 2D-lattice grating 18. The grating 18 is etched into the bottom surfaces 20 of the channels 16, over a section of the cavity. This section has a length L of approximately $50\,\mu\text{m}$, and is located towards the back facet 6 of the device, for example approximately $50\,\mu\text{m}$ from the back facet.

Figure 2 is an enlarged view of the etched grating pattern in one of the channels 16. The array comprises a series of holes 22, etched through the top contact 14 to a depth which is comparable to the depth of the active region 10. In this illustrated embodiment, the holes 22 are arranged in a hexagonal array. That is, each hole away from the edge of the array is surrounded by six equally spaced holes. This separation a is of the order of $0.60-0.65\mu m$, and the holes have a radius r such that the radius-to-pitch ratio r:a is 0.17, although it may be in the range of 0.17-0.33.

The grating pattern could also be a square array, or any pattern which provides a suitable reflector.

Preferably, the holes are etched to a depth which

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is very close to, or, more preferably, into the active region.

Advantageously, the holes can be obtained by post-processing using any available etching technique, for example, focused ion bean etching (FIBE) or reactive ion etching (RIE), without requiring any subsequent regrowth. This has the advantage that the device can be manufactured relatively simply and inexpensively.

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This structure has the further advantage that the holes, which act as the reflectors, provide a high refractive index contrast ratio between the holes and the material of the device, of approximately 1:3.5.

In order to improve passivation, it is possible to fill in the etched holes with a suitable material, such as benzocyclobutene (BCB), which reduces this ratio to approximately 1.5:3.5. However, this ratio is sufficiently large that a highly selective characteristic can be obtained, over a short etched length.

The post-etch performance of the device is characterised in terms of the optical spectra.

Measurements are taken at room temperature (20°C) under CW bias conditions. Figure 4a shows the pre-etch spectrum before AR coating at 60mA. This is indicative of a typical multi longitudinal mode F-P structure. Figure 4b illustrates clearly that, after etching, the device lases in a single longitudinal mode. Purely single mode operation is maintained over the entire operating current range up to over 3 times threshold. A typical SMSR value of >30dB is measured.

In order to investigate the stability of the lasting wavelength, the light current characteristics under CW bias conditions are measured at room temperature. Figure 5 shows a linear response above threshold, with no kinks evident, indicating that modehopping does not occur. A slope efficiency of 0.09 W/A

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is measured along with an output power of greater than 2.5mW at twice threshold current. At room temperature, a reduction in threshold current of 2mA was observed as a result of the etch.

Single mode operation is further evidenced in Figure 6, which shows the variation of peak wavelength with CW bias current at room temperature (20°C). From threshold up to 85mA, the lasing wavelength is found to vary linearly at 0.009nm/mA, indicating mode-hop-free operation. The device spectra remain single mode over this range. Single mode emission is found to vary at the rate of 0.08nm/°C around room temperature.

One possible use of the device of the invention is in an integrated device which has, say, four such laser sources on a single device, with the distributed reflector structures of the four sources being different, such that the integrated device can selectively provide a source at any of four wavelengths.

There is thus described a technique which allows manufacture of a single-contact, mode-hop-free single longitudinal mode laser operating CW at room temperature, and bit rates up to approximately 10 GHz, to be produced from a previously multi-mode Fabry-Perot ridge-waveguide device.

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CLAIMS:

- 1. An optical device, comprising a laser diode having a ridge waveguide located above an active layer, and having a distributed reflector in the form of a lattice of individual elements, wherein the elements are arranged in a two-dimensional array on either side of the ridge waveguide.
- An optical device as claimed in claim 1,
 wherein the distributed reflector comprises a structure in material above the active layer on either side of the ridge waveguide.
 - 3. An optical device as claimed in claim 1 or 2, wherein the two-dimensional array is in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.
 - An optical device as claimed in claim 1, 2 or
 wherein the individual elements are holes.
 - 5. An optical device as claimed in claim 4, wherein the holes are arranged in a hexagonal array.
 - An optical device as claimed in claim 4, wherein the holes are arranged in a square array.
 - 7. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is perpendicular to the plane parallel to the active layer.
 - 8. An optical device, as claimed in one of claims 4 to 6, wherein the holes extend to a depth comparable to that of the active layer in a direction that is not perpendicular to the plane parallel to the active layer.
- 9. An optical device, as claimed in one of claims 4 to 8, wherein the holes are regions of different refractive index to that of the device structure.
 - 10. An optical device, as claimed in one of

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claims 4 to 9, wherein the holes are regions of different gain or loss to that of the device structure.

- 11. An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector does not pierce the active region.
- 12. An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector partially pierces the active region.
- 13. An optical device, as claimed in one of claims 3 to 10, wherein the distributed reflector fully pierces the active region.
 - 14. An optical device, as claimed in any preceding claim, wherein the distributed reflector is within the device.
- 15. An optical device, as claimed in claim 14, wherein the distributed reflector is within a pumped region.
 - 16. An optical device as claimed in claim 14, wherein the distributed reflector is within an unpumped region.
 - 17. An optical device as claimed in any preceding claim, with means for varying the electrical bias or biases applied to the device to obtain efficient optical emission in single wavelength operation.
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 18. An optical device, as claimed in claim 17, wherein the emission wavelength may be controlled/tuned.
 - 19. An optical device, as claimed in any preceding claim, which is integrated with separate amplifying, absorbing or passive sections.
 - 20. An optical device, as claimed in claim 19, where the amplifying or absorbing sections have gain/loss modulation.
- 21. An optical device, as claimed in any
 preceding claim, with means for being pulsed by gain
 switching, Q-switching or mode-locking techniques.

AMENDED SHEET

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



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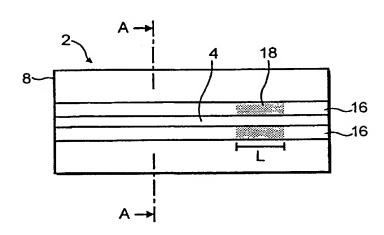
- (74) Agent: O'CONNELL, David, Christopher; Haseltine Lake & Co., Imperial House, 15-19 Kingsway, London WC2B 6UD (GB).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
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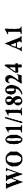
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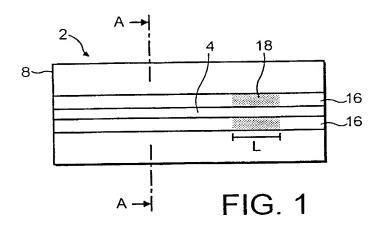
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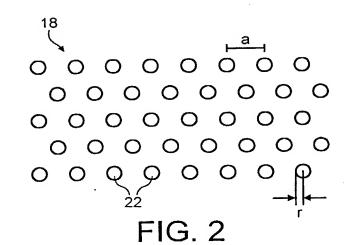


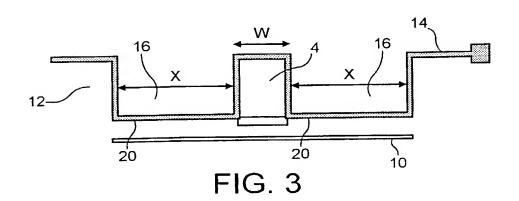
(57) Abstract: There is disclosed a laser diode with a ridge waveguide (14), in which a distributed reflector takes the form of an array of holes (22) etched into the surface of the device on either side of the central waveguide.



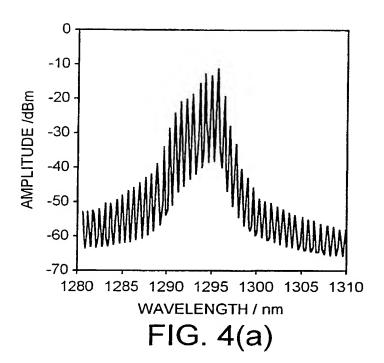
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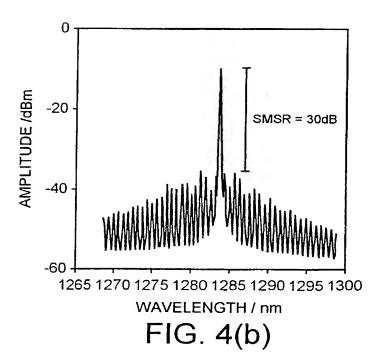






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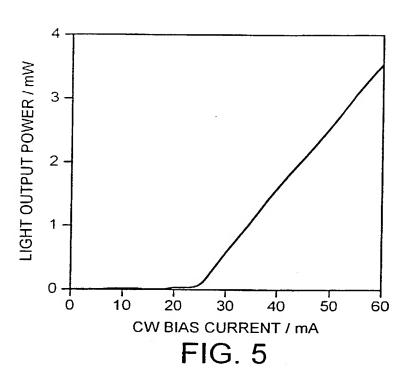
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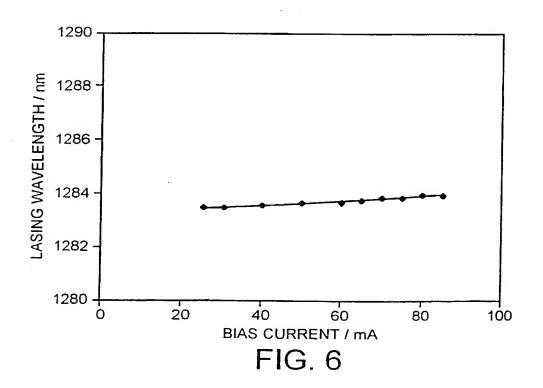
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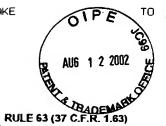
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Nixon & Vanderhye P.C. (10/99)

(Domestic Non-Assigned/Foreign) Page 1

2490-17 HL76966/002/DCO/JJM

INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is solubly on the inventor entitled.

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	(check applicable box(s)):			
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was filed on	March 8, 2002	as U.S. Application Serial No.	10/070,619	(Atty Dkt, No. 2490-17)
	nternational application No.	PCT/GB00/03483	on 08/09/2000	
and (if applicable to U.S.	or PCT application) was amended	1 on	•	
amendment referred to all defined in 37 C.F.R. 1.56 listed below and have als	bove. I acknowledge the duty to of i. I hereby claim foreign priority be io identified below any foreign app or, if no priority is claimed, before to on(s):	tents of the above identified specifical lisclose to the Patent Office all information inefits under 35 U.S.C. 119/365 of amplication for patent or inventor's certification date of this application: Country	ation known to me to be	material to patentability as
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		or Ornigeo States and PCT Internation	ai applications listed abo	ve or below:
Prior U.S./PCT Applicati	ion(s):			Status: patented
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oe rue; and further that in mprisonment, or bolh, un application or any patent i 8 Floor, Arlington, VA 2 attomeys thereof (of the s. n the Patent and Tradema Hosmer, 30184; Robert W.	nese statements were made with I der Section 1001 of Title 18 of the issued thereon. And on behalf of 22201-4714, telephone number (ame address) individually and collark Office connected therewith and / Fans, 31352; Richard G. Besha, 3; Leonard C. Mitchard, 29009; Di	knowledge are true and that all states the knowledge that willful false statems. United States Code and that such withe owner(s) hereof, I hereby appoint 703) 816-4000 (to whom all communectively owner's/owners' attorneys to d with the resulting patent: Larry S. N. 22770; Mark E. Nusbaum, 32348; M. Larpe M. Rivers, 3333; Leffor H. Neley.	ents and the like so made ifful false statements man NIXON & VANDERHYE nications are to be dire prosecule this application ixon, 25640: Arthur R. C. ichael J. Keenan, 32105; pp. 30481: John R. Lasto	e are punishable by fine or y jeopardize the validity of the P.C., 1100 North Glebe Rd. cted), and the following n and to transact all business rawford, 25327; James T. Ryan H. Davidson, 30254.
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 $oxed{ imes}$ See attached sheet(s) for additional inventor(s) information!!



2490-17 Serial No. 10/070,819 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign) Page 2

Inventor's Signature:			Oate:				
Inventor;	Richard (first)	V.	Penty (last)	British (citizenship)			
Residence: (city)	Bristol		(state/country) Great Britain	(Chizenship)			
Mailing Address:	55 Redland Road, Bristo	ol, Great Britain					
(Zip Code)	BS6 6AG						
Inventor's Signature:			Date:				
Inventor:	lan	Н.	White	British			
	(first)	MI	(last)	(citizenship)			
Residence: (city)	Bath			(Gilz Cristing)			
Mailing Address:	57 Coombe Park, Westo	n, Bath, Great Britain					
(Zip Code)	BA1 3NH	, .,,,					
	Inventor: Residence: (city) Mailing Address:	Inventor: Residence: (city) Mailing Address: (Zip Code) Inventor: Signature: Inventor: Inventor: Residence: (city) Mailing Address: Residence: (city) Mailing Address: Richard (first) Bristol BS6 6AG Inventor: Ian (first) Bath 57 Coombe Park, Westo	Inventor: Residence: (city) Mailing Address. (Zip Code) Inventor: Inventor: Residence: (city) Inventor: Inventor: Residence: (city) Residence: (city) Mailing Address: Residence: (city) Mailing Address: Richard (first) Bristol Bristol Bristol, Great Britain BS6 6AG Ian (first) MI Bath For Coombe Park, Weston, Bath, Great Britain	Inventor: Richard V. Penty (last) Residence: (city) Mailing Address: (Zip Code) Inventor: Inven			

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Nixon & Vanderhya P.C. (10/99)

(Domestic Non-Assigned/Foreign) Page 1

2490-17 HL76966/002/DCO/JJM

RULE 63 (37 C.F.R. 1.63) INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is tisted below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

maner	which is claimed and for	which a patent is sought o SEMICONDUCTOR L	n the invention entitled: .ASER DIODE WITH A DISTRIBUTE	REFLECTOR	•
the spe	cification of which (chec	k applicable box(s)):		- TELLETON	
	s attached hereto				
=	was filed on	March 8, 2002	as U.S. Application Senal No.	10/070.619	(Atty Dkt. No. 2490-17)
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and (if applicable to U.S. or F		Tapplication) was amende	d on		
amenor defined listed be which p	tient referred to above. In 37 C.F.R. 1.56. I her elow and have also iden	t acknowledge the duly to o why claim foreign priority be tified below any foreign app	ntents of the above identified specifica disclose to the Patent Office all inform anefits under 35 U.S.C. 119/365 of an ollication for patent or inventor's certific the filing date of this application;	ation known to me to	be material to patentability as
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	9921445.4		Great Britain		Day/Month/Year Filed 8 September 1999
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nereby	claim the benefit under	35 U.S.C. 120/365 of all pr	ior United States and PCT internation	at applications listed	above or below:
	S./PCT Application(s):				Status: patented
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ittomeyon the Pa dosmer, Stanley (r. 29366 4776; U 5329; J elete an	r, Arington, VA 22201- s thereof (of the same as atent and Trademark Off , 30164; Robert W. Faris C. Spooner. 27393; Leo 6; Mary J. Wilson, 32955 Jødeep S. Gill, 37334; M oseph A. Rhoa, 37515; ny ettorney names/numb	4714, Wiepnone number (ddress) individually and collice connected therewith an, 31352; Richard G. Besha, and C. Mitchard, 29009; Di; J. Scott Davidson, 33489 ichael J. Shea, 34725; Dor Raymond Y. Mah, 41428; Cers no longer with the firm.	the owner(s) hereof, I hereby appoint (703) 816-4000 (to whom all communicatively owner's/owners' attorneys to do with the resulting patent: Larry S. N., 22770; Mark E. Nusbaum, 32348; Mi uane M. Byers, 33363; Jeffry H. Nelso; Alan M. Kagen, 36178; Robert A. Monald L. Jackson, 41090; Michelle N. Le Chris Comunizis, 31097; Gery T. Tangand to act and rely solely on instruction (xon & Vanderhye on behalf of the owners).	nications are to be oprosecute this application, 25640; Arthur Fichael J. Keenan, 321n, 30481; John R. Lealan, 29834; B. J. Sacster, 32331; Frank Pijawa, 43180. Jalsos produced to compusion of the compusion of	directed), and the following atlon and to transact all business R. Crawford, 25327; James T. 106; Bryan H. Davidson, 30251; astova, 33149; H. Warren Burnan doff, 36663; James D. Berquist, . Presta, 19828; Joseph S. Presta
	Inventor's Signature:			Date:	
	Inventor:	Aeneas		Massara	British
	Osaldan 1 to 1	(first)	MI	(last)	(citizenship)
	Residence: (city)	Essex	(state/count	y) Great Britain	
	Mailing Address:	8 Garthwood Close, We	st Berghott, Colchester, Essex, Great	Britain	
	(Zip Code)	CO6 3EA			
_	Inventor's Signature:	1/ / 5	rest.	Data	30 104 12 2
ω	inventor:	baurence	<u>6</u>	Sargent	30/04/2002
\mathcal{M}^{-1}		(first)	△ MI.	(last)	' British
1~	Residence. (city)	Marlow, Buckinghamshii	re (TBX (state/countr		(citizenship)
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/	(Zip Code)	SL7 3BU	Distance of the state of the st		
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 $oxed{ imes}$ See attached sheet(s) for additional inventor(s) information!!



2490-17 Serial No. 10/070,619 Nixon & Vanderhye P.C. (10/99 (Domestic Non-Assigned/Foreign) Page 2

3.	Inventor's Signature:				Date:	
	Inventor:	Richard	V.	Pe	enty	British
		(first)	MI	` (IE	ast)	(clüzenship)
	Residence: (city)	Bristol		(state/country)	Great Britain	(C-C-C-III)
	Mailing Address:	55 Redland Road, Bristol,	Great Britain			
	(Zip Code)	BS6 6AG				
4.	Inventor's Signature:		·		Date:	-
	Inventor:	lan	Н.	W	hite	British
	n n	(first)	MI	(la	ist)	(citizenship)
	Residence: (city)	Bath		(state/country)	Great Britain	(-11-10/10/11/2)
	Mailing Address:	57 Coombe Park, Weston,	Bath, Great Britain	- ' ''		=
	(Zip Code)	BA1 3NH		V		· · · · · · · · · · · · · · · · · · ·

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Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

2490-17 HL76966/002/DCO/JJM

RULE 63 (37 C.F.R. 1.63) INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the inventor entitled:

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	pecification of which (check	capplicable box(s)):			
בַ	is attached hereto				
3	was filed on	March 8, 2002	as U.S. Application Serial No.	10/070,619	(Alty Dkt. No. 2490-17)
3	was filed as PCT Internati	onal application No.	PCT/GB00/03483	on 08/09/2000	
nd (if applicable to U.S. or PCT		application) was amended	on		
nen fine ted nich	idment referred to above. I ed in 37 C.F.R. 1.56. I here below and have also identi	acknowledge the duty to di by claim foreign priority bei fied below any foreign appl	tents of the above identified specifical isclose to the Patent Office all information filts and information for the Patent of inventor's certification for patent or inventor's certificate filing date of this application:	ation known to me to be	material to patentability as
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Nixon & Vanderhye P.C. (10/99

2490-17				Nixon &	Vanderhye P.C. (10/99
Serial No. 10/070,619				(Domestic	Non-Assigned/Foreign)
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3. Inventor's Signature:	× ///.	~h		Date:	3/7/02
Inventor:	Richard	ν	Pe	nty	British
$n \parallel$	(first)	MCAY		st)	(citizenship)
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Mailing Address:	55 Redland Road, Bristo	H. Great Britain NOME	FARM H	OUSE , MEETI	NG LANE,
(Zip Code)	BSO CATLIN	IGTON LANE	ROYSTON	2C8 DO	FAN
4. Inventor's Signature:				Date:	
Inventor:	lan	H.	W	rite	British
	(first)	MI	(la	st)	(citkzenship)
Residence: (city)	Bath		(state/country)	Great Britain	
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(Zip Code)	BA1 3NH				

2490-17 HL769 02/DCO/JJM

Nixon & Vanderhye P.C. (10/99) (Domestic Non-Assigned/Foreign) Page 1

RULE 63 (37 C.F.R. 1.63) INVENTORS DECLARATION FOR PATENT APPLICATION IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, mailing address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

	pecification of which (che is attached hereto	rk applicable hov/s)):	SER DIODE WITH A DISTRIBUTE!	3 1 LL LLC C C C C C C C C	
	was filed on	March 8, 2002	as U.S. Application Serial No.	10/070,619	(Atty Dkt. No. 2490-17)
and (was filed as PCT Interna		PCT/GB00/03483	on 08/09/2000)
	if applicable to U.S. or PC	T application) was amended o	on		
amen define listed which	dment referred to above. ed in 37 C.F.R. 1.56. I her below and have also iden	I acknowledge the duty to dis reby claim foreign priority bene tified below any foreign applic	ents of the above identified specifical close to the Patent Office all informations efits under 35 U.S.C. 119/365 of any cation for patent or inventor's certification date of this application:	ation known to me to by foreign application(s	pe material to patentability as) for patent or inventor's certific
	Application Num	ber	Country		Day/Month/Year Filed
	9921445.4		Great Britain		8 September 1999
l herel	by claim the benefit under Application Num		ited States provisional application(s) Date/Month/Year Filed	listed below.	
I hereb	by claim the benefit under	35 U.S.C. 120/365 of all prior	United States and PCT internations	al applications listed a	bove or below:
Prior (Applic	U.S./PCT Application(s): cation Serial No. PCT/GB00/0348		Day/Month/Year Filed 08/09/2000		Status: patented pending, abandoned
applica 8 th Floo attorne in the F Hosme Stanley Jr. 2930 34776; 35329; delete a	ntion or any patent issued or, Arlington, VA 22201- ys thereof (of the same as a tent and Trademark Office, 30184; Robert W. Faris C. Spooner, 27393; Leon 66; Mary J. Wilson, 32955 Updeep S. Gill, 37334; M Joseph A. Rhoa, 37515; lany attorney names/numb	thereon. And on behalf of the 4714, telephone number (70 ddress) individually and collectice connected therewith and w, 31352; Richard G. Besha, 2; and C. Mitchard, 29009; Duar; J. Scott Davidson, 33489; A ichael J. Shea, 34725; Donalc Raymond Y. Mah, 41426; Chrers no longer with the firm and	nited States Code and that such will owner(s) hereof, I hereby appoint It 3) B16-4000 (to whom all commurtively owner's/owners' attorneys to point the resulting patent: Larry S. Ni 2770; Mark E. Nusbaum, 32348; Michel M. Byers, 33363; Jeffry H. Nelson and M. Kagen, 36178; Robert A. Mod It. Jackson, 41090; Michelle N. Lesis Comuntzis, 31097; Gary T. Tanig to act and rely solely on instruction & Vanderhye on behalf of the ow	NIXON & VANDERHY ilications are to be dif orosecute this application, 25640; Arthur R. chael J. Keenan, 3210 n, 30481; John R. Las lan, 29834; B. J. Sado ster, 32331; Frank P. I awa, 43180. I also au is directly communica	E P.C., 1100 North Glebe Rd. rected), and the following ion and to transact all business Crawford, 25327; James T. 6; Bryan H. Davidson, 30251; tova, 33149; H. Warren Burnar ff, 36663; James D. Berquist, Presta, 19828; Joseph S. Presthorize Nixon & Vanderhye to
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oxtimes See attached sheet(s) for additional inventor(s) information!!

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